1.What is deep learning? Explain. What are its applications? Discuss.

Introduction

A Fourth Industrial Revolution is building as digital revolution that has been occurring since the middle of the last century. It is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres. Artificial intelligence is a crucial part of this fourth industrial revolution. And Deep learning is one of the important aspects of Artificial Intelligence.

Body

Deep Learning is a subfield of machine learning concerned with algorithms inspired by the structure and function of the brain called artificial neural networks.

Deep learning (aka deep structured learning or hierarchical learning) is part of a broader family of machine learning methods based on learning data representations, as opposed to task-specific algorithms.

Deep learning neural network consists of two terms:

1) Neural networks, a biologically-inspired programming paradigm which enables a computer to learn from observational data.
2) Deep learning, a powerful set of techniques for learning in neural networks

Application of Deep learning

- Self-driving cars where the neural networks can be trained over parameters such as traffic patterns, traffic rules, weather and road quality etc. and it can self-improvise to drive efficiently.
- Weather forecasting where training parameters could be wind pattern, air-pressure, temperature and previous weather records of the year etc. so that it could predict weather phenomena without human intervention.
- Automatic machine translation, deciphering complicated scripts and language modeling.
- Automatic Game Playing – A recent example is AlphaGo which beat the world champion.
- Examination of huge amount of space data to come out with patterns and new discoveries.
- Robotics and Internet of Things (IoT) are the areas that can significantly improve our interaction with outer world.
- Restoration of old paintings, identification through low resolution images, automatic music composing etc.
- Border management with hostile neighbourhood can be done through computer vision, including object recognition, etc. with minimal loss of life and property.

- Crime and investigations, huge pending cases are serious problem before Indian judiciary and administration. Machine learning can help in solving cases, bioinformatics and DNA profiling etc.

Conclusion

- There is huge potential for machine learning in realising the dream of new India but this will not happen until the personal biases mentioned previously, and these "greed" biases are addressed.
- It is also not recommended to completely rely on machines in certain sectors such as health and such other areas of human interface.
- It must be taken care that replacement of human with intelligent machines would not increase the socio-economic inequalities and deprivations in society

2. What is quantum computing? How can it change the way computers perform? Examine.

Introduction

Quantum computing is a new type of computing that relies on quantum physics unlike traditional computing which is based on binary processing of information. It uses 'qubit' built by the way of some objects behave at the subatomic level or at extremely cold temperature.

Body

Changing the computer performance:

Exploiting the principles of quantum mechanics, quantum computing help computers to easily tackle computational problems that may be tough for the classical computer as the size of the numbers and number of inputs involved grows bigger. It uses the fundamental laws of quantum physics to perform an incomprehensible number of calculations simultaneously.

- Qubits: Unlike binary bits which can be either '1' or '0', qubit can be both '0' and '1' at the same time which is called quantum superposition. This helps the computer hold more information. Two qubits can hold four values at once. And as the number of qubits grows, a quantum computer becomes exponentially more powerful. E.g. Google's quantum computer 'Sycamore' took under 3 minutes for a calculation that would take a supercomputer 10,000 years.
- Quantum computing uses the principle of entanglement which means they can manipulate all their qubits simultaneously. Thus, instead of doing a set of calculations one after another, a quantum computer could do them all at the same time.

- Parallel computing: It can simulate several classical computers working in parallel and hence change the fundamental way of working of computers. E.g. Bell Labs in 1996 discovered that a quantum computer would be able to do a task with one thousand steps instead of a million taken by classical computer.
- Encryption and security: several encryption systems used in banking and security applications are premised on computers being unable to handle mathematical problems that are computationally demanding beyond a limit. With quantum computing, the way of computer encryption needs an upgradation. At the same time, quantum computing also can be a solution with quantum encryption methods that can be employed.
- Instead of troubleshooting issues bit by bit as we do now with classical computers, quantum computers tackle the entire problem at once. This opens the door for amazing developments in every field from financial services to our national security.

Quantum computers reduces the number of computers and hence reduce the physical space and energy requirements. With these advantages, it has applications in every field from AI, Banking, Defence applications, Big data analytics, Medicine and so on.

However, a more careful analysis show that quantum computing still has limitations specially in solving real time problems. There are still hardware issues, unique propensity to errors and are not as amenable to executing real world problems as super computers.

Conclusion

Thus, quantum computing is a revolution in the field of computing and is an upgrade of the present-day supercomputers. USA and China are taking lead in quantum computing. The need to invest in quantum computing researches is realized by India which has unveiled a programme called Quantum-Enabled Science & Technology (QuEST).

3. What is CRISPR? What are its current and potential applications? Discuss.

Introduction

In popular usage, "CRISPR" is shorthand for "CRISPR-Cas9." CRISPRs are specialized stretches of DNA. The protein Cas9 is an enzyme that acts like a pair of molecular scissors, capable of cutting strands of DNA.
CRISPR technology is a simple yet powerful tool for editing genomes. It allows researchers to easily alter DNA sequences and modify gene function. Its many potential applications include correcting genetic defects, treating and preventing the spread of diseases and improving crops.

Body

Current applications of CRISPR

- **Improving IVF** – In 2016, a Swedish research team led by Fredrick Lanner edited DNA in healthy human embryos with CRISPR. Carrying out gene editing within human embryos could help to improve chances of pregnancy during IVF treatments. As well as benefitting IVF, scientists also hope to use CRISPR to reduce miscarriages.
- **Antimicrobial and antiviral fields** – Cas9 endonucleases, as molecular DNA scissors guided by gRNA, are now used to target and cut exogenous DNA arising from virus or plasmids.
- **Breeding and reproduction** – Strategies that use the CRISPR/Cas9 technique to improve the reproduction in swine are becoming popular.
- **Immunization and xenotransplantation** – The advancement of the CRISPR/Cas9 technique has greatly strengthened the ability to effectively manipulate porcine genome in order to evaluate and generate porcine organs that can assist in xenotransplantation.
- The technology had been used to functionally inactivate genes in human cell lines and cells, to modify yeasts used to make **biofuels** and to genetically modify **crop strains**.
- In July 2019, doctors in United States, used CRISPR to experimentally treat a patient with a **genetic disorder**. The patient was a 34-year-old woman with sickle cell disease.

Potential applications of CRISPR

- **Extracting HIV** – One of the greatest triumphs so far has been the successful removal of HIV from human immune cells. This is a major advancement in potential HIV treatment, as the virus is prone to re-infect victims. The method was shown to be safe for human cells, and could provide a more long term treatment for patients.
- **Fighting cancer** – Perhaps CRISPR's most celebrated application is in detecting and treating cancer. Scientists are currently using the technique to explore the biology of cancerous brain tumors with the aim of producing specialised treatment. By picking apart cancer cells, researchers can decipher which genes are most important to the disease's survival. In 2016, Chinese scientists began testing CRISPR edited immune cells in lung cancer sufferers. Results have yet to be released, but human trials herald good things for the fight.
- **Making diseases self-destruct** – At the University of Wisconsin Madison, food scientist Jan-Peter van Pijkeren is developing an antibiotic that makes pathogens 'commit suicide'. Through a DNA slicing enzyme called Cas, CRISPR chops up the genes of invading bacterium. Then, a CRISPR laced bacteriophage (which infects bacteria) is inserted into the pathogen, rewiring it to destroy itself.
- **Eliminating malaria** – Various university teams are working on the elimination of malaria in mosquitos, in the hope of stopping human infection.

Through CRISPR Cas 9, scientists can snip out genes that are vital to the spread of malaria within the mosquito population. In short, they could create mosquitos that were resistant to malaria.

- **Protecting plants** – Using CRISPR to kill weeds might seem like a trivial application, however they are a serious problem for farmers globally and can drastically impact crop yield. Equipping plants with resistance genes could lead to reduced reliance on pesticides and herbicides. Recently, Monsanto revealed a new global licensing agreement to use CRISPR within agriculture, alongside the Broad Institute of MIT and Harvard.
- **Producing food** – Researchers at Tokushima University announced the creation of seedless tomatoes using CRISPR.
- **Creating biofuel** – A partnership between J. Craig Venter and Exxon Mobil has used CRISPR to improve the energy production of algae.
- **Reviving extinct mammals** – As future gazing as it sounds, a team at Harvard University has revealed plans to bring back the woolly mammoth with CRISPR. By combining elephant genes with mammoth genes recovered from fossils, the researchers hope to create hybrid embryos which could then be grown in an artificial womb.

Conclusion

CRISPR has already disrupted cancer treatment, cured HIV in living organisms, caused diseases to kill themselves, and destroyed harmful genes. Outside of healthcare, the technique has impacted FoodTech, ecology, conservation efforts and sustainable energy. In light of the advancements that have already been made, CRISPR's future potential is outstanding.

4. How do voice assistants function? What are their day to day applications? Examine.

Introduction

A voice assistant is a digital assistant that uses voice recognition, natural language processing and speech synthesis to provide aid to users through phones and voice recognition applications.
Voice assistants are used in phone lines, smartphones and other places to assist users with tasks, including listening to an audiobook, requesting information, inputting a search query, making reservations, adding items to a shopping list, performing mathematical calculations, playing music.

Body

How do voice assistants function?

- In general voice assistants react to voice commands and give the user relevant information about his inquiry.

- For the voice-enabled world, smartspeakers have shown to hold a lot of potential. These have a microphone to “hear” and speakers to communicate back to us or play music.
- The smart part is their direct connection to the internet and advanced speech recognition software. The software can understand and react to specific commands. Asking the voice assistant in the smartspeaker for tomorrow’s weather is a good example. The assistant will decipher the human voice command and then act independently by searching the web for the right answer and reading it back to the user.
- The software is the actual core of the artificial intelligence that enables the smartspeaker to answer our specific questions and human commands. Being able to understand and process our questions is the great challenge voice assistants have to master. Meaning a voice assistant has to be able to learn and make use of languages to be able to pick the right answers to our commands.
- In the combination of the physical and digital parts of the smartspeaker lies their great potential to act as a bridge in-between humans and their computers or machines.

Applications of voice assistant technology

- Health Care – It can provide personalized medicine and X-ray readings. Personal health care assistants can act as life coaches, reminding you to take your pills, exercise or eat healthier.

- Manufacturing: AI can analyze factory IoT data as it streams from connected equipment to forecast expected load and demand using recurrent networks, a specific type of deep learning network used with sequence data.

- Home automation – It can interact with smart home appliances and run the show. Eg – Marvel comic based Iron man’s virtual assistant Jarvis.

- Food ordering – Voice assistant can be used to order food just by voice command. Eg – Many companies have collaborated with Alexa and their website support Alexa like Domino’s, Pizza hut, Starbucks etc.

- Entertainment – Voice assistant can recognize the command and play music. Ex: Alexa, Siri can play music from streaming services such as Apple Music and Google Play Music from a phone or tablet. Also allows the user to hear updates on supported sports teams.

- Messaging and Email – Voice assistant can help in sending text messages and Email without any need for physical interference. Ex: Messages can be sent from one Alexa application to another as well as Echo devices.

- Weather – It can help in controlling indoor temperature depending on the command given. It can also provide weather reports.

- Operating appliances: It can help in operating appliances at home like making coffee, switching on/off lights and also probably park cars, among others.

Conclusion

It's pretty safe to assume voice assistants will achieve more popularity in the next years. While the technology still has a long way to go to deliver super smart assistants, it's clear it's no longer the joke it used to be when it was launched. Moreover, with the rise of artificial intelligence and the Internet of Things (IoT), they'll become even more advanced and better at helping their users handle their daily tasks.

5. How are reusable rockets changing the space exploration industry? Illustrate.

Introduction

The space industry is in the middle of a widespread transformation, as the last decade has seen a number of young companies begin to seek to profit through development of a reusable launch system. Today's rockets are one shot wonders. They burn up fuel in a few minutes and splash down into terrestrial oceans, having put their payload on the right trajectory. This is wasteful and that is why scientists have dreamt of building reusable launch vehicles which would help in future space exploration.

Body

- The holy grail of rocket launchers is a concept referred to as the single stage to orbit (SSTO) vehicle. The idea is to use a reusable launch vehicle (RLV) which has the capability to deliver a payload to orbit, re-enter the Earth's atmosphere and land, where it can then be refuelled. The process can then be repeated with a short turnaround.
- Reusable launch vehicles reduce cost by allowing space agencies to shave off the expense of the recovered stage for every subsequent launch. These reusable rockets have drastically cut launch costs — from $200 million to $60 million—and the figure is projected to come down to $5 million. Governments too have taken note of the trend.
- According to noted billionaire, Elon Musk, "If one can figure out how to effectively reuse rockets just like airplanes, the cost of access to space will be reduced by as much as a factor of a hundred. A fully reusable vehicle has never been done before. That is the fundamental breakthrough needed to revolutionise access to space."
- NASA's Space Shuttle typified this paradigm for many decades, but it was SpaceX's Falcon 9 rocket that really popularised it. It showed that reusable

rockets didn't have to be as large as the Space Shuttle and didn't require infrastructure at that scale either. Since then, many space agencies – public and private – have been pursuing their own reusable launcher programmes.

- In May this year, the Indian Space Research Organisation successfully flight tested its 'Reusable Launch Vehicle – Technology Demonstrator' (RLV-TD) from the Satish Dhawan Space Centre (SDSC) in Sriharikota, Andhra Pradesh. This winged craft, with its distinctive twin tail-fins, is intended as a key step toward the space agency's goal of creating a reusable launch vehicle that could cut launch costs by as much as nine-tenths.
- Advances in reusable rockets, lowered per-launch costs and miniaturization of satellites are opening up business opportunities which can make the global space industry to generate revenue of $1.1 trillion or more in 2040, up from the current $350 billion, according to a recent report.
- The Idea of exploiting celestial resources is older than any space exploration programme. As of now near Earth asteroids (NEA) appear to be suitable candidates for first mining incursion outside the planet. In this regard, reusable rockets would provide the wherewithal to achieve this goal.
- With SpaceX, Boeing, Virgin Galactic, and Blue Origin all inching closer to making history as the first privately funded companies to launch commercial passengers into space, reusable rockets will surely make 2020 the Year of Commercial Space Travel. Here, developing reusable rockets is about making space tourism a reality.
- Individuals and enterprises flush with funds are the key players in the present space race. They are betting on a future in which space is more accessible, enjoyable and exploitable, and public trips to Mars and back are a reality. Many have termed this as the dawn of the entrepreneurial space age.
- Following are some of the benefits or advantages of Reusable Rocket:
    - Cost for launching becomes much cheaper as it reduces material cost due to reusability.
    - Some of the reusable rockets use kerosene (of rocket grade type) as fuel which do not generate harmful chlorine as exhaust. This helps to protect the environment.
    - Effectively we can reuse rockets similar to airplanes, hence space travel will become cheaper to a greater extent.
- Ultimately, reusable rockets will make it possible for humans to explore deep space, and colonise other planets. SpaceX recently unveiled a design for its Interplanetary Transport System (ITS) - a system that involves using reusable rockets to propel spaceships filled with hundreds of passengers to Mars.

Conclusion

Space economy now includes everything from launch and satellites (both hardware for data sourcing and software for data analytics and applications), industrials (extractives and manufacturing), logistics (situational awareness, debris mitigation, on-orbit servicing), biospheres (habitats and life support systems), interplanetary (deep space technologies), information and research, and media and education

where reusable rockets would form the bedrock of making humans a multiplanetary civilization in the near future.